The Chemistry of Color Pigments: Engineering Green Chemistry Solutions to Achieve Product Stewardship Goals

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Pigments Used in 4-Color Printing

- Black (carbon black)
- Diarylide Yellow (CI Pigment Yellow 12)
- Phthalocyanine Blue (CI Pigment Blue 15)
- Monoazo Red (CI Pigment Red 57:1)

History of Color Pigments

- Carbon Black – invented ?
- Diarylides– invited in 1912
- Metalized azos – invented in 1900's
- Copper Phthalocyanines – invented in 1907
- Latest family of pigments developed for commercial printing
  - Diketopyrrolopyrrole – invented in 1970's
- New pigments invented every 20-60 years
- Continued development of pigments for printing inks – difficult to substitute

Color Pigments Characteristics & Customer Requirements

- Chroma
- Broad shade functionality
- Durability/lightfastness
- Opacity/transparency
- Low metamerism
- Dispersibilty
- Heat stability
- Solvent resistance
- Gloss retention

- Color strength
- Fitness for purpose (performance level)
- Regulatory status
- Cost
- Availability

- Each pigment is **unique** to fit its intended use in commerce and **difficult to substitute**.

By-products & Side Reactions

- All chemical reactions have by-products and side reactions
- Chemical hierarchy
- Improve chemical yield in theory
  - Example: remove BOD & COD from waste water
- Reduced performance characteristics due to elimination of by-products
- Some by-products governed by regulation
  - Example: chlorinated solvents

Industry Practical Solutions

- Reduced use of chlorinated solvents
- Modified buffers
- Process optimization
- Sometimes “solutions” have not been the best solutions
- Interaction between industry and regulatory authorities – timely input into rule-making decisions

Sustainability

- Efficiency of energy utilization
- Efficiency of raw materials
- Examples:
  - Use of water is not efficient
  - Soy bean oil vs petroleum-based oil → solvent has limited applicability

Conclusions

- Unique color pigments chemistries have evolved over a considerable period of time
- Color pigment manufacturing processes are highly efficient and minimize by-products
- Each pigment is unique to fit its intended use in commerce and difficult to substitute

Thank you

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